XVII. *Remarks on Mr.* Brydone's *Account of a remarkable Thunder-ſtorm in* Scotland. *By the Right Honourable* Charles *Earl* Stanhope, *F. R. S.*

Read February 15, 1787.

§ 1. NO ſtorm of lightning has ever produced effects more curious to contemplate than thoſe related by Mr. Brydone, in his Letter to the Preſident of this Society. That account contains facts of ſuch conſequence, and ſo perfectly inexplicable by the principles of electricity which are commonly received, that it undoubtedly deſerves particular attention.

It appears, that a man (named " James Lauder") ſitting on the fore-part of a cart drawn by two horſes, was ſuddenly ſtruck dead, as alſo the horſes that he was driving, and that the cart itſelf was much injured by electrical fire, although no lightning fell at, or near, the place where this accident happened.

§ 2. Before I attempt to account, by the laws of electricity, for this remarkable phænomenon, it may not be improper juſt to take notice, that few facts of this kind have ever been *better authenticated* than this is.

It appears, firſt, that a man, who was ſitting upon the fore-part of another cart, only twenty-four yards behind the cart that was ſtruck, " had Lauder, his cart and horſes, full in " view when they fell; he was ſtunned by a loud report, and " ſaw his companion, his horſes and cart, fall to the ground;

" he immediately ran to his aſſiſtance, but found him quite " dead; he perceived" (at the time of the accident) " no flaſh " or appearance of fire."

It alſo appears, that another man, a ſhepherd of St. Cuthbert's farm, was alſo a witneſs of this event. He was diſtant from LAUDER " between two and three hundred yards, and was " looking at the two carts, when he was ſtunned by a loud " report, and at the ſame inſtant ſaw the firſt of the carts fall " to the ground. He ſaw no lightning, nor appearance of fire " whatever."

The concurrent teſtimony of theſe two men is confirmed by PATRICK BRYDONE, Eſq. who lives " at a ſmall diſtance" from the ſpot where LAUDER was killed: and Mr. BRYDONE relates, that a ſtorm appeared far off; and that he, and ſome company in his houſe, were " ſuddenly alarmed by a loud " report, for which they were not prepared by any preceding " flaſh." There is the greater weight to be given to this account of Mr. BRYDONE, as it ſo happened, that he was juſt then " obſerving the progreſs of the ſtorm, at an open win- " dow, in the ſecond ſtory of his houſe," and making the company " obſerve, by a ſtop-watch, the time that the ſound " took to reach them."

It is extremely fortunate, that a gentleman, fond of philoſophical enquiries, ſhould have been upon the ſpot at the time of this accident, to give to the world ſo clear and intereſting an account.

§ 3. That the death of LAUDER and of the horſes was *not* occaſioned by any *direct main ſtroke of exploſion* from a thunder-cloud, either poſitively or negatively electrified, is evident; ſince no lightning whatever did paſs from the clouds to the earth (or from the earth to the clouds) at the place where they were killed.

§ 4. It is equally evident (and for the very ſame reaſon) that they were not deprived of life by any *tranſmitted main ſtroke of exploſion*, either poſitive or negative.

§ 5. It is alſo obvious, that the *lateral exploſion* was not the cauſe of this miſchief; for the *lateral* * *exploſion* does always proceed immediately from the main ſtroke itſelf; and therefore there can exiſt no *lateral exploſion*, in the caſe when there is no main ſtroke whatever.

§ 6. It might, perhaps, be ſuppoſed, that LAUDER and the two horſes were ſuddenly ſuffocated by the ſulphureous ſmell that often accompanies electricity.

But though the death of the man and of the horſes might (by ſome) be attributed to this cauſe, the ſulphureous ſmell will no wiſe account for "many pieces of the coal having been "thrown out, to a conſiderable diſtance, all round the cart;" and for the "ſplinters" (from the wood-work of the cart) that were "thrown off in many places," as appears, by Mr. BRYDONE's account, to have been the caſe.

§ 7. Some perſons may imagine that LAUDER and the horſes might have been killed, and that the other effects above-mentioned might be accounted for, by ſome ſudden and very violent commotion in the air, which commotion the thunder might be ſuppoſed to produce, though unaccompanied with any flaſh at that place; in a manner, in ſome ſmall degree, ſimilar to the fatal wounds that ſometimes have been known to have been given by the air having been ſuddenly diſplaced by a cannon ball, in its paſſage through that atmoſpherical fluid, though the cannon ball itſelf had evidently neither ſtruck the perſon wounded, nor even grazed his cloaths.

---

* See Dr. PRIESTLEY's excellent Paper in the ſixtieth volume of the Philoſophical Tranſactions, page 192 et ſeq. See alſo my Principles of Electricity, § 386.

567

The "duſt that roſe at the place" might be brought as an additional argument in favour of the opinion, that a ſudden and violent commotion of the air did occaſion the effects produced.

But ſuch an explanation (vague as it is) would not account for the "marks of fuſion" on the iron of the wheels; nor for "the hair of the horſes having been ſinged;" nor for "the ſkin of LAUDER's body having been burnt" in many places.

§ 8. I think, from the different circumſtances of this caſe, that it is clear to demonſtration, that the effects produced proceeded from electricity; and that *no electrical fire did paſs* immediately either from the clouds into the cart, &c. or from the cart, &c. into the clouds.

From "the circular holes" in the ground ("of about "twenty inches in diameter") the reſpective "centers of "which were exactly in the track of each wheel," and the correſponding "marks of fuſion" on the iron of the wheels, which marks "anſwered exactly to the center of each of the "holes;" it is evident, that the electrical fire did paſs (from the earth to the cart, or from the cart to the earth) through that part of the iron of the wheels which was in contact with the ground.

From the "ſplinters that had been thrown off, in many "places, particularly where the timber of the cart was con"nected by nails or cramps of iron," and from the various other effects mentioned in Mr. BRYDONE's Paper, it is moreover evident, that there was a violent motion of the electrical fluid in all, or (at leaſt) in different parts of the cart, and of the bodies of the man and horſes, although there were no lightning.

§ 9. Wonderful as theſe combined facts may appear, and uncommon as they certainly are in this country, they are, nevertheleſs, eaſy to be explained by means of that particular ſpecies of electrical ſhock, which I have diſtinguiſhed in my Principles * of Electricity (publiſhed in 1779) by the appellation of the "*electrical returning ſtroke*:" and although at the time I wrote that Treatiſe, I had it not in my power to produce any inſtance of perſons or animals having been killed in the very peculiar manner ſince related in Mr. BRYDONE's Paper; I did, however (from my experiments mentioned in that Book), venture to aſſert, with confidence, that †, "if "perſons be ſtrongly ſuperinduced by the electrical atmoſphere "of a cloud, they may (under circumſtances ſimilar to thoſe "explained in that Treatiſe) receive a very ſtrong ſhock, be "knocked down, or be even killed, at the inſtant that the "cloud diſcharges, with an exploſion, its electricity, whether "the lightning falls near the very place where thoſe perſons "are, or at a very conſiderable diſtance from that place, or "whether the cloud be poſitively or negatively electrified."

And I moreover ſtated that ‡, "whether the diſtance be"tween the perſon ſo circumſtanced, and the place where the "lightning falls, be fifty or an hundred yards, or one mile, or "two miles, or three miles, or more, the truth of the ge

---

* See Principles of Electricity, containing divers new Theorems and Experiments, together with an Analyſis of the ſuperior Advantages of high and pointed Conductors; by CHARLES Viſcount MAHON, F. R. S. from § 202. to § 347. incluſively.

† See Principles of Electricity, § 311.

‡ See Principles of Electricity, § 313.

" neral propoſition there laid down would not be any wiſe " affected."

I have alſo explained, in that Treatiſe, how a ſtill more ſingular effect might be produced, namely, how * " an exploſion, which happens in one place, may cauſe in a ſecond " place (at a very conſiderable diſtance from the firſt place) " a ſudden returning ſtroke, which may knock down, or even " kill, perſons and animals at that ſecond place; at the ſame " time that other perſons, or other animals, ſituated in a third " place, that is even immediately between the firſt place " where the lightning falls, and the ſecond place (juſt men- " tioned) where the ſhock of the returning ſtroke happens, " ſhall receive no detriment whatever."

§ 10. Having, in my Principles of Electricity †, explained at large the nature of the *returning ſtroke*, I will not treſpaſs upon the time of this Society, by repeating the account of any of the various experiments that I made, to prove the poſſible exiſtence of ſuch an electrical ſtroke; but I will, at once, apply the general laws, which I have (therein) laid down, to the particular phænomena related by Mr. BRYDONE.

But, before I ſpeak of the accident of LAUDER, which appears to me to have been occaſioned by a *returning ſtroke*, proceeding from an *aſſemblage* of clouds, I will ſay a few words upon one or two other facts, mentioned in Mr. BRYDONE's account.

§ 11. Mr. BRYDONE informs us, that " the ſhepherd belong- " ing to the farm of Lennel-Hill was in a neighbouring field, " when he obſerved a lamb (only a few yards from him) drop " down, although the lightning and claps of thunder were,

---

* See Principles of Electricity, § 314.

† See Principles of Electricity, from § 202 to § 347, incluſively.

" then,

" then, at a great diſtance from him. He ran up immediately, " but found the lamb quite dead; nor did he perceive the leaſt " convulſive motion, or ſymptom of life remaining, although, " the moment before, it appeared to be in perfect health."

This effect is ſo preciſely ſimilar to thoſe explained in my Principles of electricity, and particularly to that mentioned in ſection 328, that it is quite unneceſſary to enlarge upon it. I will only obſerve, that ſuch an electrical *returning ſtroke* as that by which this lamb was deſtroyed (namely, a returning ſtroke, which happens at a place where there is neither lightning nor thunder near) belongs to the moſt ſimple claſs of returning ſtrokes; and that it may be produced by the ſudden removal of the elaſtic electrical preſſure of the electrical atmoſphere of a *ſingle* * main cloud, as well as by that of an *aſſemblage* † of clouds.

It appears by Mr. BRYDONE's account, that the ſhepherd, who ſaw the lamb fall, was near enough to it to feel, in a ſmall degree, the electrical returning ſtroke " at the ſame " time" that the lamb dropped down.

§ 12. Mr. BRYDONE further relates, that " a woman " making hay near the banks of the river fell ſuddenly to " the ground; and called out to her companions, that ſhe had " received a violent blow on the foot, and could not imagine " from whence it came."

This blow was, unqueſtionably, the *electrical returning ſtroke*.

When a perſon, walking or ſtanding out of doors, is knocked down or killed by the *returning ſtroke*, the electrical fire muſt ruſh in, or ruſh out, as the caſe may be, through that perſon's *feet* *, and through them *only*; which would not be the caſe, were the perſon to be knocked down or killed by any main ſtroke of exploſion, either poſitive or negative.

---

* See Principles of Electricity, § 312.

† See, in my Principles of Electricity, the end of the note to § 312.

Theſe things are evident. But the manner in which LAUDER and the two horſes were killed is not quite ſo evident, though it appears to me to be very eaſily accounted for.

I will now ſtate, in what manner I conceive that the clouds may have been placed, when the effects mentioned in Mr. BRYDONE's Paper were produced.

§ 13. I muſt premiſe that, by that account, it appears, that the cloud was many miles in length; inaſmuch, as juſt before the " loud report," the lightning was at a very " great diſ-" tance:" for Mr. BRYDONE " obſerved, by a ſtop-watch, that " the time that the ſound took to reach him was generally from " 25 to 30 ſeconds."

Mr. BRYDONE relates, that the " loud report reſembled the " firing of ſeveral muſkets, ſo cloſe together, that the ear " could hardly ſeparate the ſounds, and was followed by no " rumbling noiſe like the other claps."

This deſcription indicates, that the electrical exploſion was not far diſtant; and alſo ſhews, that it was not extremely near: for, if the exploſion had been extremely near, the ear could not at all have ſeparated the ſounds.

§ 14. Now let us ſuppoſe a cloud, eight, ten, or twelve miles in length (be the ſame more or leſs) to be extended over the ſurface of the earth, in the ſituation repreſented by ABC in the figure. (See Tab. VIII.)

And let another cloud (as repreſented by DEF) be ſituated between the above-mentioned cloud and the earth.

---

* See Principles of Electricity, from § 322. to § 327. incluſively.

Let the two clouds be ſuppoſed to be charged (for inſtance) with the *ſame* kind of electricity, and to be both poſitive.

Let us further ſuppoſe, that the lower cloud DEF be near the earth, only a little beyond the ſtriking diſtance; and let a man, cart and horſes, be ſituated at L, under that part (E) of the cloud which is the neareſt to the earth.

Now, let us ſuppoſe this cart to be aſcending an hill, and to be in the ſituation deſcribed by Mr. BRYDONE, namely, to have "almoſt gained the higheſt part of the aſcent," and to be followed by "another cart" (M) lower down the hill.

Let us ſuppoſe alſo, that the two clouds DEF and ABC be near each other, perpendicularly over the place where the cart L was ſituate (as at DA).

And let the remote end C, of the upper cloud ABC, approach the earth, within the ſtriking diſtance, and ſuddenly diſcharge its electricity into the earth at G.

§ 15. Things being ſituated as above deſcribed, let us examine what conſequences muſt follow.

Firſt, when the upper cloud ABC diſcharges its electricity into the earth at G, the lower cloud DEF muſt immediately diſcharge its electricity into the upper cloud at the place DA, which is directly or nearly over the cart L.

This accounts for the "loud report" of thunder that was unaccompanied by lightning at L or at M. The *report* muſt be loud, from its being near; but no *lightning* could be perceived at L or M, by reaſon of the thick thunder cloud DEF being ſituated immediately between the ſpectator at M and DA, the place between the two clouds where the lightning was.

ſituation repreſented in the figure; the earth at L muſt, of courſe, become ſuperinduced by the elaſtic electrical preſſure of the electrical atmoſphere of the thunder-cloud; which ſuperinduced elaſtic electrical preſſure muſt gradually have increaſed as the cloud came cloſer to the earth, and approached nearer to the limit of the ſtriking diſtance.

§ 17. Conſequently, if any conducting body (not having any prominent conducting points) were to be placed at L, upon the ſurface of the earth, and to be there *electrically inſulated*; then ſuch conducting body, by the laws of electricity, muſt, at its upper extremity (namely, the part neareſt to the *poſitive* cloud) become *negative*; at its lower extremity, it muſt become *poſitive*; and, at a certain intermediate point, it will be neither *plus* nor *minus*.

So that this inſulated conducting body, thus ſituated, will be in three oppoſite ſtates at one and the ſame time; that is to ſay, that it will be, at the ſame inſtant, *poſitively* electrified, *negatively* electrified, and not electrified at all.

This propoſition I have rigorouſly demonſtrated in my Treatiſe * on Electricity.

§ 18. But if this conducting body, on the ſurface of the earth, be *not inſulated* †, or be but imperfectly inſulated, then the *whole* of ſuch body (from its being immerged in the electrical atmoſphere of the *poſitive* cloud) will become *negative*; becauſe part of the electricity of this conducting body will, in this caſe, paſs into the earth. And this conducting body will become the more *negative*, as it becomes the more deeply immerged into the denſe part of the elaſtic electrical atmoſphere of the approaching thunder-cloud.

---

* See Principles of Electricity, from § 55 to § 74, incluſively.

† See Principles of Electricity, § 182 and § 183.

§ 19. Now, when the poſitive cloud DEF (in the manner above ſtated) comes ſuddenly to diſcharge, with an exploſion, its ſuperabundant electricity into the other cloud ABC, then the elaſtic electrical atmoſphere of the cloud DEF will ceaſe to exiſt; conſequently, the electrical fluid, which had been gradually expelled into the common ſtock, from the conducting body ſituated (at L) upon the ſurface of the earth, muſt (by the ſudden removal of the ſuperinduced elaſtic electrical preſſure of the electrical atmoſphere of the thunder-cloud) ſuddenly return from the earth into the ſaid conducting body, producing a violent * commotion, ſimilar to the pungent ſhock of a *Leyden jar* in its ſenſation and effects.

This is what I call the electrical *returning* † *ſtroke.*

§ 20. It was by ſuch a returning ſtroke that LAUDER and the horſes that he was driving were killed, they having become ſtrongly *negative* ‡ previous to the exploſion.

LAUDER was "ſitting" when he was ſtruck dead; and his legs appear to have been "hanging over the fore-part of the "cart, at the time of the exploſion." The returning ſtroke, therefore, could not iſſue into his body through his legs; and this accounts for the "ſkin of his legs" not having been at all "burnt or ſhrivelled," as the ſkin was on many other parts of his body. And it likewiſe ſhews the reaſon, why the "zig-"zag line" on LAUDER's ſkin (which was terminated at one end by the chin) "did not extend lower than the thigh."

---

* See Principles of Electricity, § 304 and § 603.

† See Principles of Electricity, from § 202 to § 208, incluſively, and § 387.

‡ Note, I have here ſuppoſed the thunder-cloud (and of courſe its electrical atmoſphere) to have been *poſitive*; but ſimilar effects would have been produced if the thunder-cloud had been *negative*; only, in that caſe, LAUDER and the horſes would have been ſtrongly poſitive, previous to the exploſion.

§ 21. Mr. BRYDONE mentions, that "the hair of the horſes "was much ſinged over the greateſt part of their bodies; but "was moſt perceptible on the belly and legs." This effect is eaſily accounted for by the returning ſtroke; for the lower part * of the bodies of thoſe animals muſt of courſe have been more ſtrongly affected than any other part, as the electrical fire from the earth muſt ſuddenly have ruſhed into their bodies through "their legs, which had made a deep impreſſion "in the duſt."

§ 22. The various effects produced on the cart may be explained, with equal facility, by means of the returning ſtroke; and I have ſtated, in my Principles † of Electricity, "not "only in what manner perſons and animals may be deſtroyed, "but how" inanimate bodies, ſuch as "particular parts of build-"ings, may be conſiderably damaged by an electrical returning "ſtroke, namely, all thoſe parts where there is, in any kind "of conducting ſubſtance or ſubſtances (upon which a ſtrong "elaſtic electrical preſſure is ſuperinduced), any kind of elec-"trical interruption, acroſs which the returning electrical fire "might ſuddenly ſtrike, and might thereby rend and deſtroy "all the bodies that it might meet with in its paſſage."

Mr. BRYDONE relates, that "ſplinters had been thrown off "in many places, particularly where the timber of the cart was "connected by nails or cramps of iron." The electrical interruption between theſe pieces of metal, acroſs which interruption the returning electrical fire did ſuddenly ſtrike, accounts for its rending the bodies that it met with in its paſſage.

---

* See, in my Principles of Electricity, the note to § 594, where ſomewhat of a ſimilar effect is mentioned.

† See Principles of Electricity, § 333, § 334, and § 347.

It is alſo evident, that it was the electrical returning fire, that produced the "marks of fuſion" on that part of the iron of the wheels which was in contact with the ground; inaſmuch as the whole electricity, that, at the inſtant of the exploſion, returned into the cart, did enter at thoſe places.

§ 23. No perſon, the leaſt verſed in the principles of electricity, can heſitate to aſſent to the propoſition, that the *electrical returning ſtroke* muſt exiſt, under circumſtances ſimilar to thoſe explained above. But it may be objected to me, that although all the aforeſaid effects of a returning ſtroke might take place in a ſmall degree, yet thoſe effects could not have been ſufficiently powerful to have killed LAUDER, the horſes, and the lamb, or to have melted the iron of the cart-wheels; eſpecially, conſidering the ſmall quantity of electrical fluid that is contained in the body of a man, of a lamb, or of a horſe; or that is contained in any body of the ſize of a common cart; that is to ſay, conſidering the ſmall quantity of electrical fluid that could, by being diſturbed, have produced the *returning ſtroke*.

To this objection (plauſible as at firſt ſight it may appear) I conceive, I have given a complete anſwer in my Principles of Electricity, from ſection 337 to ſection 347, incluſively; and alſo from ſection 592 to ſection 606, incluſively; but it may not be improper to add a few words to what I have already ſaid upon that part of the ſubject.

§ 24. No legitimate concluſion can be drawn from premiſes that are not proved: therefore, no perſon can legitimately conclude, that the force of a returning ſtroke muſt always be weak, when produced by the diſturbed electrical fluid of a man's body, by reaſon that a man's body contains but a ſmall quantity of electricity: for, it has never been proved, that a man's body does contain only a *ſmall* quantity of electrical fluid; neither is there the ſmalleſt reaſon to believe ſuch an hypotheſis, which appears, on many accounts, to be completely erroneous. And, if that hypotheſis be erroneous, the objection to the ſtrength of an electrical returning ſtroke remains perfectly unſupported by argument.

When a body is ſaid to be *plus* or *poſitive*, it ſimply means, that the body contains *more* electricity than it does in its unelectrified, that is to ſay, natural ſtate; but does not ſignify, that ſuch body is completely ſaturated * with electricity. In like manner, when a body is ſaid to be *minus* or *negative*, it only ſignifies, that the body contains *leſs* than its natural ſhare of electricity; but does not imply, that ſuch body is *completely exhauſted* of the electricity which it contains in its natural ſtate.

Now, the ſtrength of natural electricity is ſo immenſe, when compared to the very weak effects of our largeſt and beſt contrived electrical machines, that I conceive, that we cannot, by means of artificial electricity, expel, from a man's body, the thouſandth (or perhaps even the ten thouſandth) part of the electrical fluid which it contains, when in its natural ſtate.

§ 25. That hypotheſis, by which natural phænomena are eaſily accounted for, has a better claim to our attention than an oppoſite hypotheſis, which prevents thoſe phænomena from being intelligibly explained.

There is no reaſon whatever for concluding, that any electrical machine of any *given* ſize is capable of rendering a conducting body either *completely plus*, or *completely minus*; but far otherwiſe. And it would have been as logical, for any perſon, ſome years ago (when electrical machines were not brought to their preſent ſtate), to have maintained, that thoſe very imperfect machines were capable of rendering a conducting body *completely poſitive*, or *completely negative*, as for us, in the year 1787, to conclude, that we (by our ſtill imperfect machines) have attained the limit of electrical exhauſtion, or condenſation.

---

* See Principles of Electricity, § 342.

We evidently have not, with our machines, even approached the limit of electrical ſtrength, particularly in reſpect to the *returning ſtroke*: for it is remarkable, that (by the laws of electricity *) the ſtrength of the electrical *returning ſtroke*, near the limit of the ſtriking diſtance, does increaſe in a "greater ratio," than the ſtrength of the main ſtroke from the charged body, producing the elaſtic electrical atmoſphere ſuperinduced.

§ 26. For example, let the returning ſtroke be attempted to be produced, by means of a metallic prime conductor of 20 or 21 inches in length, and of about two inches in diameter; and by means of another metallic body of equal dimenſions, placed parallel to the prime conductor, juſt out of the limit of the ſtriking diſtance; and let the prime conductor be charged, by means of one of the common glaſs globes, of leſs than nine inches in diameter.

The returning ſtroke, in this caſe, will not only be conſiderably weaker than a ſpark taken from the prime conductor, but it will be ſo extremely weak, that it can hardly be ſaid even to exiſt.

§ 27. Whereas, if the experiment be made in a manner exactly ſimilar, by means of a *large* glaſs cylinder (inſtead of the ſmall globe) and by means of a metallic prime conductor, of about three feet four inches long †, by nearly four inches and a half diameter*; and alſo by means of another metallic body of equal dimenſions with this prime conductor; then, there will be no kind of compariſon between the ſtrength of the *returning ſtroke* obtained out of the ſtriking diſtance of the prime conductor, and the ſtrength of the *main ſtroke* received immediately from the prime conductor, the ſharpneſs and pungency of the *returning ſtroke* being ſo much ſuperior. The returning ſtroke in this caſe is like the ſudden diſcharge of a weakly electrified *Leyden jar*, provided that due attention be paid to the four rules for obtaining a very ſtrong returning ſtroke, as laid down in ſection 307 of my Principles of Electricity.

---

* See my Principles of Electricity, § 340 and § 341.

† It is better if the prime conductor, and the other metallic body, be ſtill larger.

§ 28. When I performed the experiment of the returning ſtroke, by means of a ſtill ſtronger electrical apparatus, the commotion † felt was ſimilar to that of a *Leyden jar*, ſtrongly electrified, ſuddenly diſcharged through my body; ſo that, having taken the returning ſtroke eight or ten times one morning (without having taken the *main ſtroke* a ſingle time that day), I felt a conſiderable degree of pain acroſs my cheſt during the whole evening, and a diſagreeable ſenſation in my arms and wriſts all the next day.

I have alſo found, that (by an advantageous diſpoſition of the apparatus) metal ‡ may be melted by means of the *electrical returning ſtroke*, not only entirely out of the *ſtriking diſtance*, but even without any communication with the common ſtock, although the conducting body, from which iſſued the electrical fluid that formed the *returning ſtroke*, had leſs than *twenty-ſeven* ſquare feet of ſurface in contact with the air.

---

* See Principles of Electricity, § 593, 594, and 595.

† See Principles of Electricity, § 304 and § 310.

‡ See Principles of Electricity, from § 603 to § 606, incluſively.

§ 29. The fact is, that in the caſe of the returning ſtroke, it is not ſo much upon the *quantity* of electrical fluid, as upon the *velocity* * of that fluid, that the ſtrength of that ſtroke depends; therefore, the ſtrength of the *returning ſtroke* depends leſs upon the *quantity of ſurface* uſed, than upon the *ſtrength* of the electrical preſſure of the elaſtic electrical atmoſphere, ſuperinduced upon the body ſtruck, previous to the exploſion.

But, the electrical preſſure of the elaſtic electrical atmoſphere of the great thunder-cloud in Scotland muſt have been immenſe, when compared to the electrical preſſure of the elaſtic electrical atmoſphere of a metallic prime conductor, of whatſoever ſhape; conſequently, it is not at all ſurpriſing that LAUDER ſhould have been killed (or that the other effects, related by Mr. BRYDONE, ſhould have been produced) by the *returning ſtroke*; inaſmuch as it is not ſurpriſing, that *effects* ſhould be proportionate to the *cauſes* by which they are reſpectively produced.

§ 30. Mr. BRYDONE relates, that "LAUDER's cart was "higher on the bank" than the cart that followed him; which, in ſome degree, accounts for the man, ſitting on the other cart, *not* having felt the returning ſtroke. But, that is to be accounted for in another way, namely, by ſuppoſing the cloud to have been pending nearer to the earth, over the ſpot where

---

* See Principles of Electricity, from § 592 to § 602, incluſively; and particularly § 601.

LAUDER * was killed, than over the place where his companion was: for, I have ſhewn, in my Treatiſe upon Electricity †, that, in order for a perſon to receive a dangerous returning ſtroke, ſuch perſon ſhould be immerged, not merely in the electrical atmoſphere of the thunder-cloud, but in the denſe part of the cloud's electrical atmoſphere.

The fact above alluded to may alſo be accounted for in the following way, *viz.* by ſuppoſing that the ſecond cart were either better connected with the common ſtock, or that it were better inſulated, than LAUDER'S cart: for, I have ſhewn, in my Principles of Electricity ‡, (what is very remarkable, namely,) that *either* of theſe two *oppoſite* circumſtances will weaken the force of a returning ſtroke prodigiouſly. Now, Mr. BRYDONE mentions, that there had been an "almoſt total want of rain "for many months." He alſo ſays, that "the ground" (at the place where LAUDER was killed) "was remarkably dry, "and of a gravelly ſoil." This ſtate of the ground was particularly adapted to the production of the electrical returning ſtroke, when produced upon the large ſcale of nature, where the elaſtic electrical preſſure is ſo powerful.

§ 31. The account which Mr. BRYDONE has given of this thunder-ſtorm in Scotland is not more curious than it is inſtructive.

---

* See Principles of Electricity, § 318.

† See, in my Principles of Electricity, Experiments 38, 39, and 40, from § 280 to § 296, incluſively. See alſo § 312, § 318, § 334, and § 307.

‡ See Principles of Electricity, from § 248 to § 310, incluſively; and ſee particularly § 307.

In part XIX. of my Principles of Electricity [*], I have enumerated "eleven neceſſary requiſites" in erecting conductors to ſecure buildings againſt damage by lightning. The ninth requiſite is [†], "that there be neither large nor prominent bodies "of metal, upon the top of the building propoſed to be "ſecured, but ſuch as are connected with the conductor" (and conſequently with the common ſtock) "by ſome proper metal-"lic communication." And in ſection 538, I ſtate, that the "conſideration of the electrical returning ſtroke fully evinces the "utility of ſuch precaution." The circumſtances mentioned by Mr. BRYDONE, that "ſplinters had been thrown off in "many places, particularly where the timber of the cart was "connected by nails, or cramps of iron," ſtill more fully proves that ſuch precaution is right.

§ 32. The tenth [‡] neceſſary requiſite in erecting conductors, mentioned in my Principles of Electricity, is, "that there be "a ſufficient number of rods." And in ſection 542 I ſtate that, "the higheſt parts of a building, the moſt elevated "ridges, all the very prominent ſtacks of chimneys, and all "the moſt ſalient angles, ought, in order for the building to "acquire the greateſt degree of ſecurity, to be armed with "an high, tapering, and acutely pointed metallic conductor, "properly connected with the common ſtock. And upon edi-"fices of great importance (eſpecially magazines of gun-"powder) the pointed conductors ought never to be above

---

[*] See Principles of Electricity, from § 519 to § 544, incluſively; and particularly ſee § 519.

[†] See Principles of Electricity, § 519 and § 538.

[‡] See Principles of Electricity, § 519; and from § 539 to § 542, incluſively.

" forty or fifty feet aſunder; and, if they were to be at ſtill " ſmaller diſtances aſunder, the ſecurity they would afford " would be ſtill more perfect."

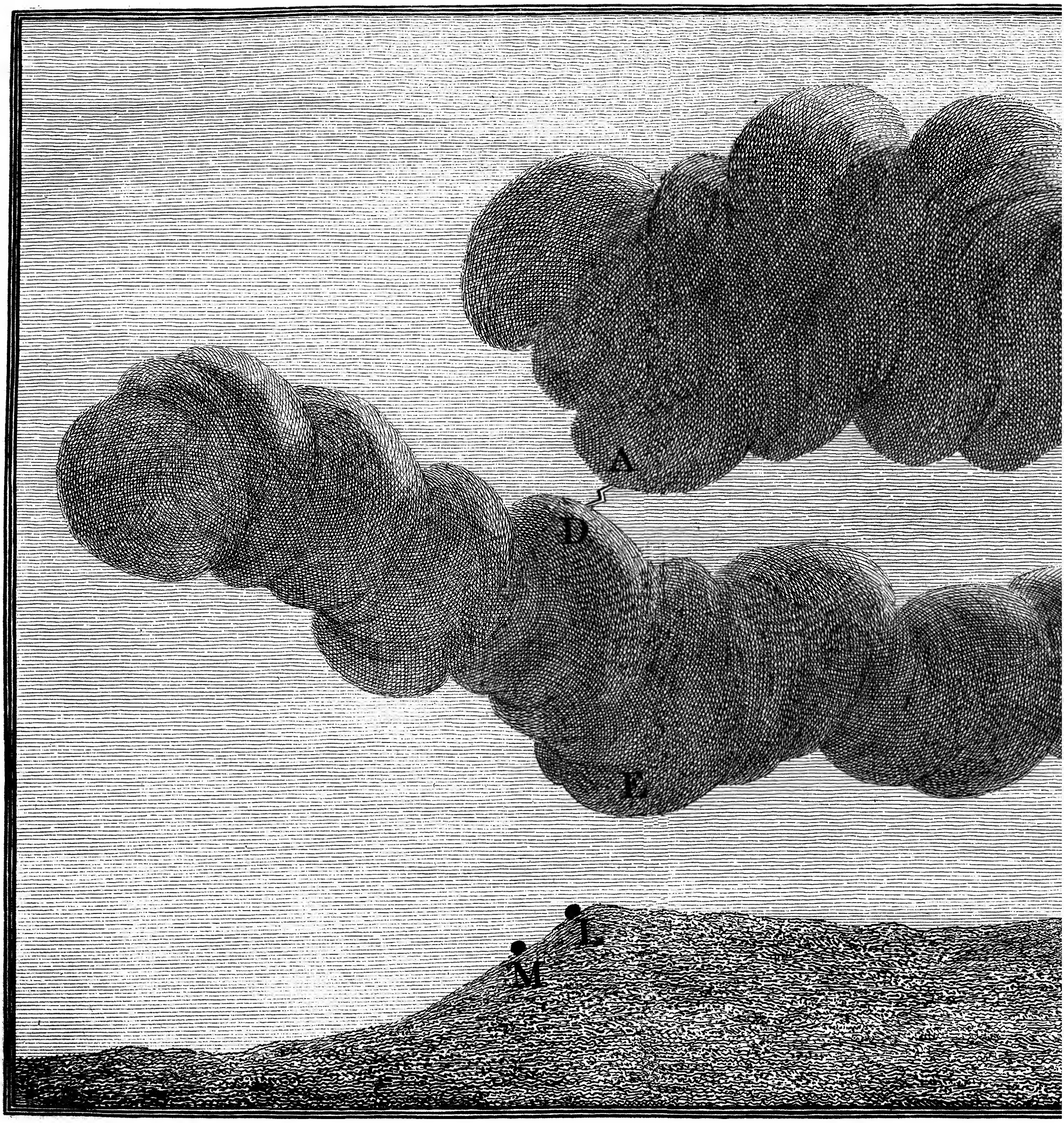
The reaſon of this precaution is fully explained in many parts of the above-mentioned Treatiſe, particularly in ſection 423*; and the circumſtance, very worthy of obſervation, related by Mr. Brydone, namely, that the diſtance was only " about *twenty-four yards*," between Lauder, who was killed, and his companion, who " was ſenſible of no ſhock, nor uncommon ſenſation," does clearly demonſtrate the propriety of this precaution, of erecting *ſeveral* † conducting rods upon an extenſive building.

This information muſt be particularly intereſting to the Board of Ordnance, on account of the ſecurity of their magazines, particularly their powder magazines at Purfleet. The ſecurity of thoſe magazines is a great national object, not only on account of their importance in time of war; but, alſo on account of their vicinity to the City of London. For, from the immenſe quantity of gunpowder they contain (when full), their ſituation upon the river Thames, and their being within the diſtance of only a few miles of London, thoſe magazines being blown up would probably produce, in the Metropolis, a violent ſhock, like that of an earthquake.

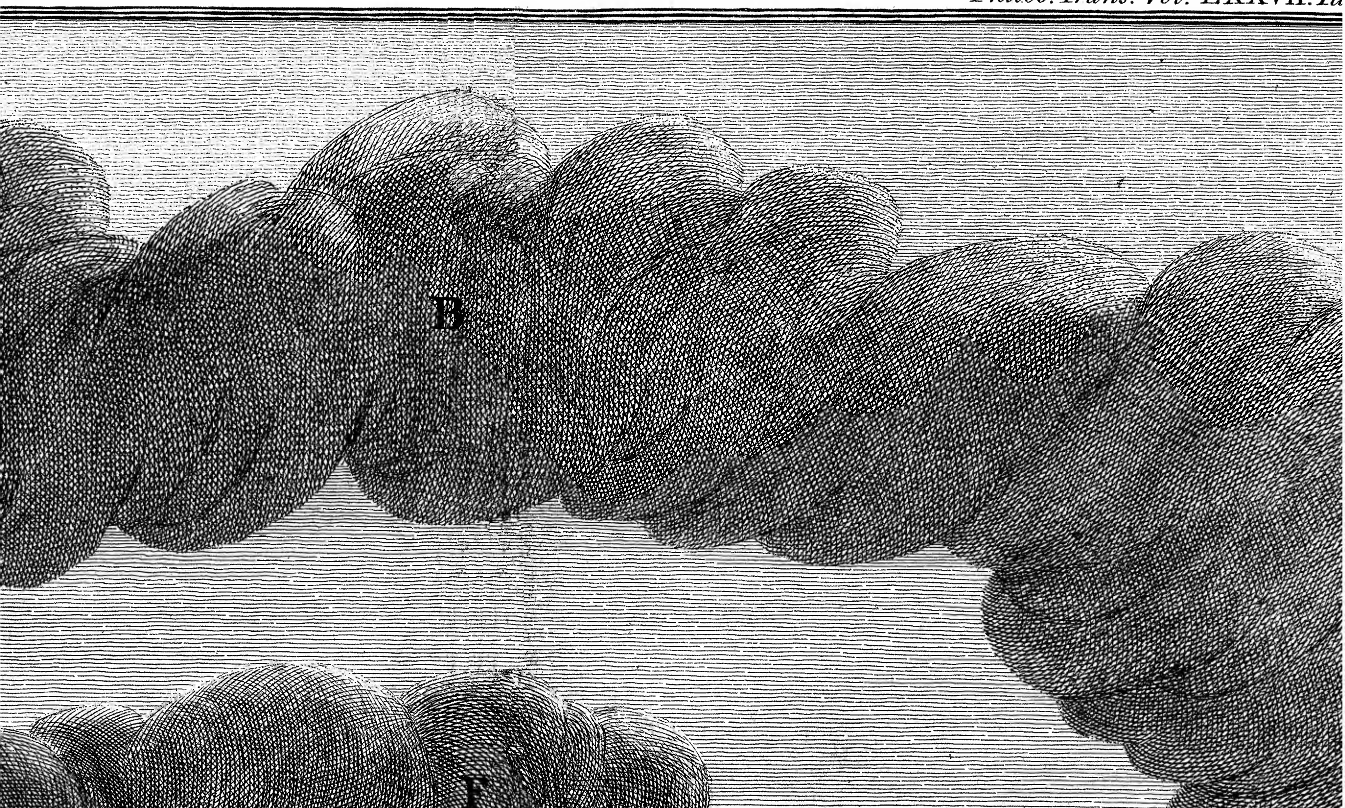
---

* See alſo Part XVIII. of my Principles of Electricity (from § 494 to § 518 incluſively), where I have clearly demonſtrated this propoſition, namely, that, " *high and pointed metallic conductors* [when properly conſtructed, and when made to " communicate completely with the common ſtock] tend not only to prevent " a *main ſtroke of lightning* and the *lateral exploſion*; but tend likewiſe moſt power-" fully to prevent any dangerous *electrical returning ſtroke* whatever from taking " place near that part of the edifice upon which they are erected. So admirable, " and ſo extenſive, is the principle upon which is founded this ſimple and moſt " incomparable invention!"

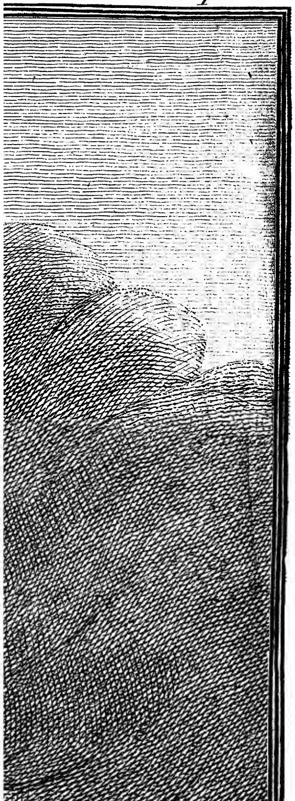
† See alſo (in the volume LXVIII. of the Philoſophical Tranſactions, part I. p. 313. et ſeq.) the " Report of the Committee, appointed by the Royal Society,
600
" to conſider of the moſt effectual Method of ſecuring the Powder Magazines at " Purfleet againſt the Effects of Lightning, in compliance with the Requeſt of the " Board of Ordnance;" in which Report, *ſeveral* high and acutely-pointed conductors, properly connected with the bottom of the wells, are propoſed to be erected; and other precautions, founded on a like principle, are recommended.


A
D
E
L
M

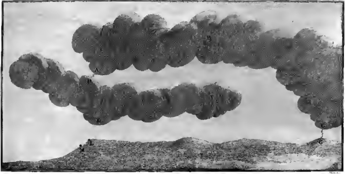
Philos. Trans. Vol. LXXVII. Ta



XVII. *Tab*. VIII. *p*. 150.



Basire Sc.


A
B